Electron-Hole Symmetry in Massless Dirac Electron System
\(\alpha-(\text{BEDT-TTF})_2\text{I}_3\) under High Pressure

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Since the discovery of graphene, condensed matter physics based on massless Dirac particles has attracted considerable attention. Linear energy dispersion structures have led to such the novel phenomena as the half integer quantum Hall effect and the Klein tunneling effect. Recently, a number of materials with massless Dirac particles have been discovered, resulting in the rapid development of the physics of Dirac fermion systems. Among them, we have discovered the massless Dirac electron system next to the charge ordered insulating phase in the temperature-pressure phase diagram of an organic conductor \(\alpha-(\text{BEDT-TTF})_2\text{I}_3\). Thus, this system provides a testing ground for the investigation of physical phenomena in strongly correlated Dirac particles. According to Elias, the Dirac cones were reshaped by the effects of the Coulomb interaction [1]. The reshaped Dirac cones by the Coulomb interaction were reexamined in \(\alpha-(\text{BEDT-TTF})_2\text{I}_3\) under the high pressure approximately 2.3 GPa by Hirata [2].

Is the electron-hole symmetry of the strongly correlated Dirac electron system maintained? To address this question, thin crystals which holes or electrons were injected by the contact electrification were prepared so that the quantum transport phenomena were investigated [3]. The Fermi velocities \(v_{\text{F}e}\) and \(v_{\text{F}h}\) of upper and lower Dirac cones were examined from the detection of the Shubnikov-de Haas oscillations. The ratio \(v_{\text{F}h}/v_{\text{F}e}\) is estimated to be approximately 1.3. This is the electron-hole symmetry of this system.